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Underground Nuclear Testing

By

Dr. Glen McDuff

Presented at

Los Alamos National Laboratory

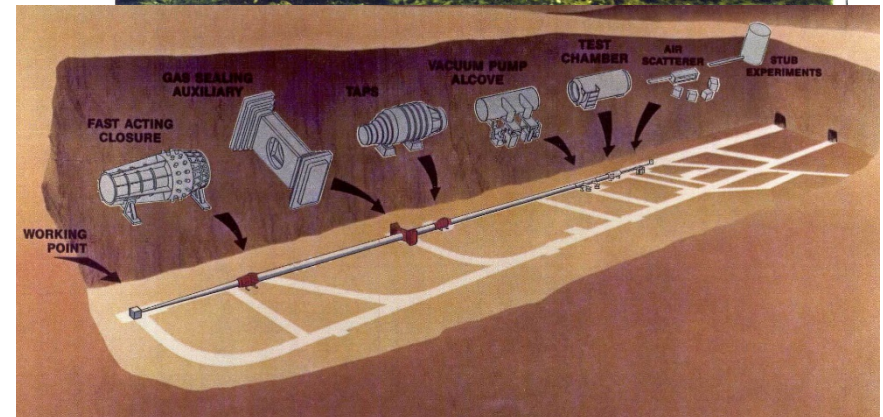




Two Types of Underground Test



Shaft



Tunnel

Weapons Development vs. Effects Testing

- **Weapons Testing (DoE)**

- LANL and LLNL w/ SNL
- Testing objectives:
 - Weapons Development
 - Safety
 - Stockpile Reliability
 - Physics Phenomenology
- Mostly in vertical shafts
- 200-400 data channels
- Normally have one name
 - Scissors, Abo, Kinibito

- **Effects Testing (DoD)**

- Nuclear weapons effects
 - Radiation effects
 - X-rays
 - Gamma, neutron
 - Blast and shock
 - Underground structures
- Tunnels (HLOS, Cavity)
- VLOS
- 1000 - 2500 data channels
- Normally two names
 - Huron King, Midas Myth

The deepest was Mandrel Rulison near
Rulison Colorado at 8200 feet.

Shafts and Drilling

- Drilling was a 24 hour a day operation.
- Holes with diameter from 3 feet to 10 feet
(LANL usually got the 4' holes and LLL got the 10')
- Depths at NTS were normally less than 1000 feet but several broke the 4500 foot mark
- Depth for Cannikin on Amchitka Island was nearly 5873 feet



Drilling (Really big drill bit)



Getting Ready to Emplace

- Up to 10,000 feet of gas locked cable
- What is “gas locked” cable
- Did everyone watch the movie?
- LANL builds the rack over hole and uses cables to suspend.
- LLNL builds the rack on a concrete pad then moves it to the hole and uses pipe to suspend.



Effect Test Tunnels

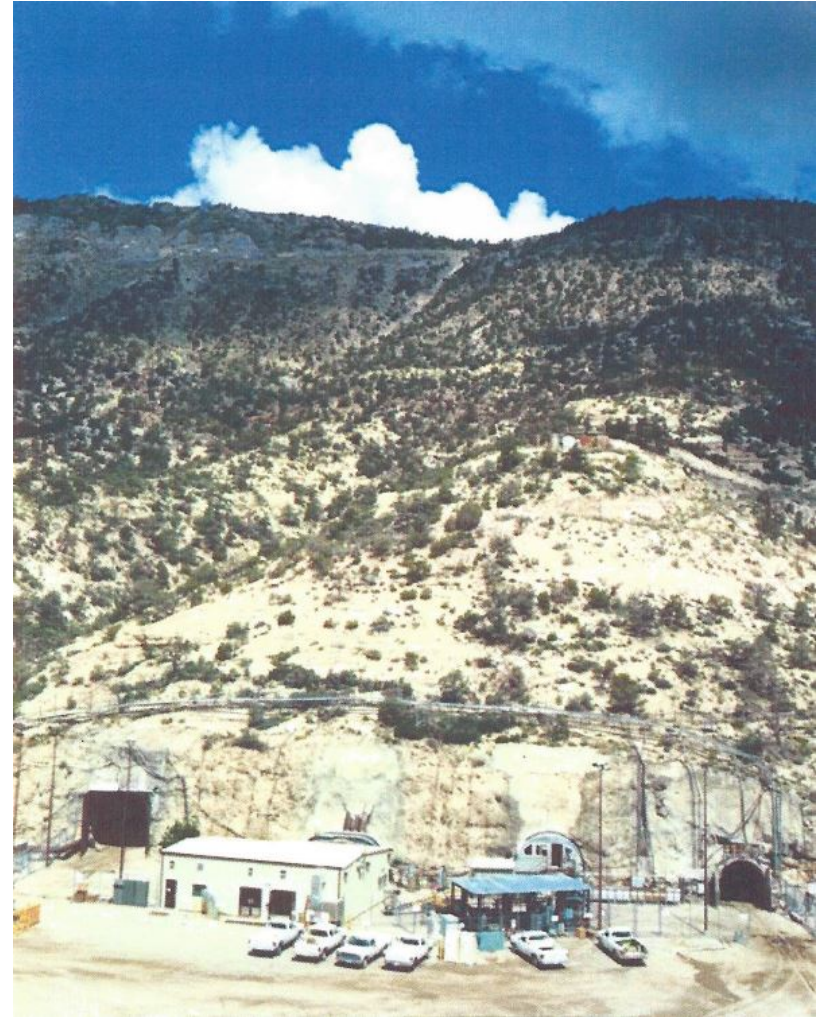
- Mining Techniques

- By hand

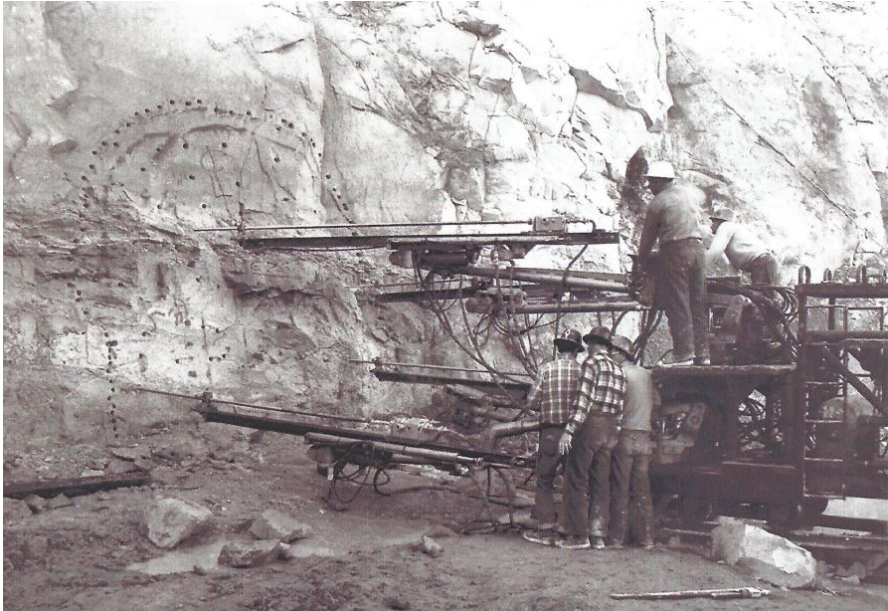
- Drill and blast

- Rotary head

- Tunnel boring machine



Drill and Blast



Rotary Head



Tunnel Boring Machine



15 – 30 ft/day



Tunnels and Cavities

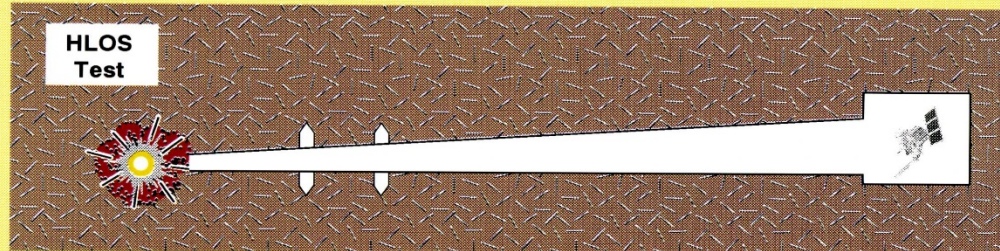


HLOS Horizontal Line of Sight Cavity

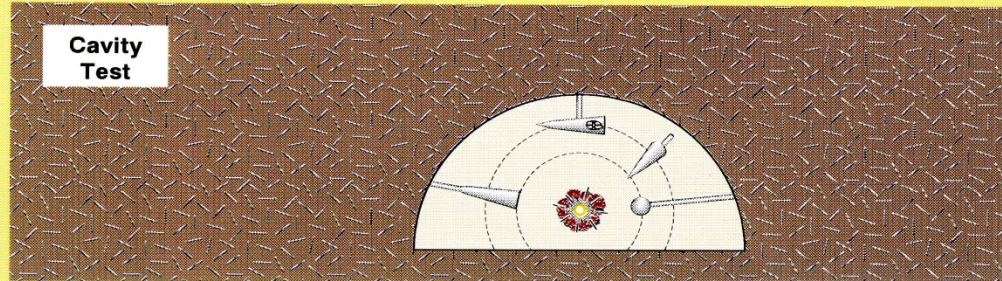


Test Execution

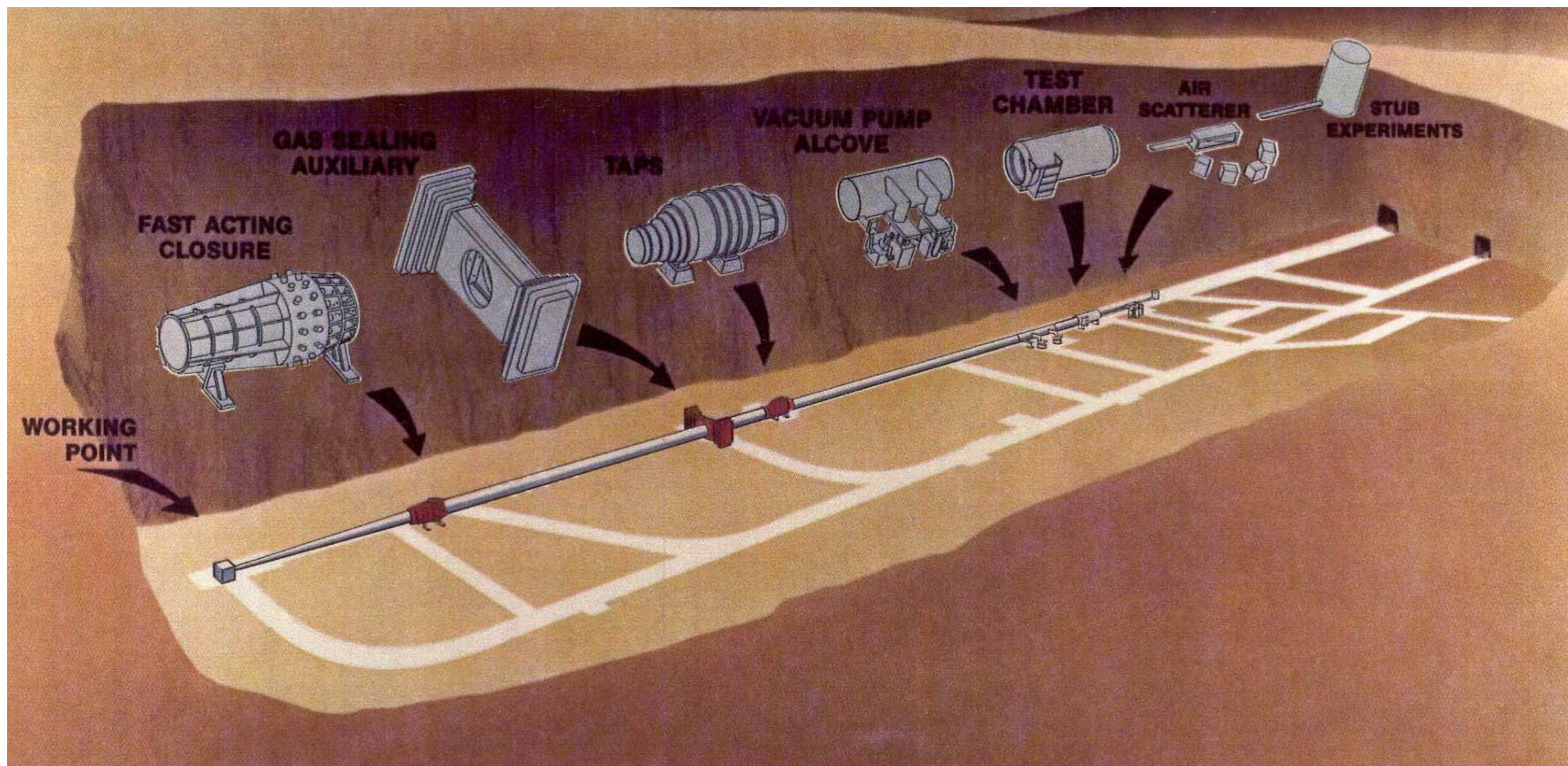
HLOS
Test



Cavity
Test



Typical HLOS

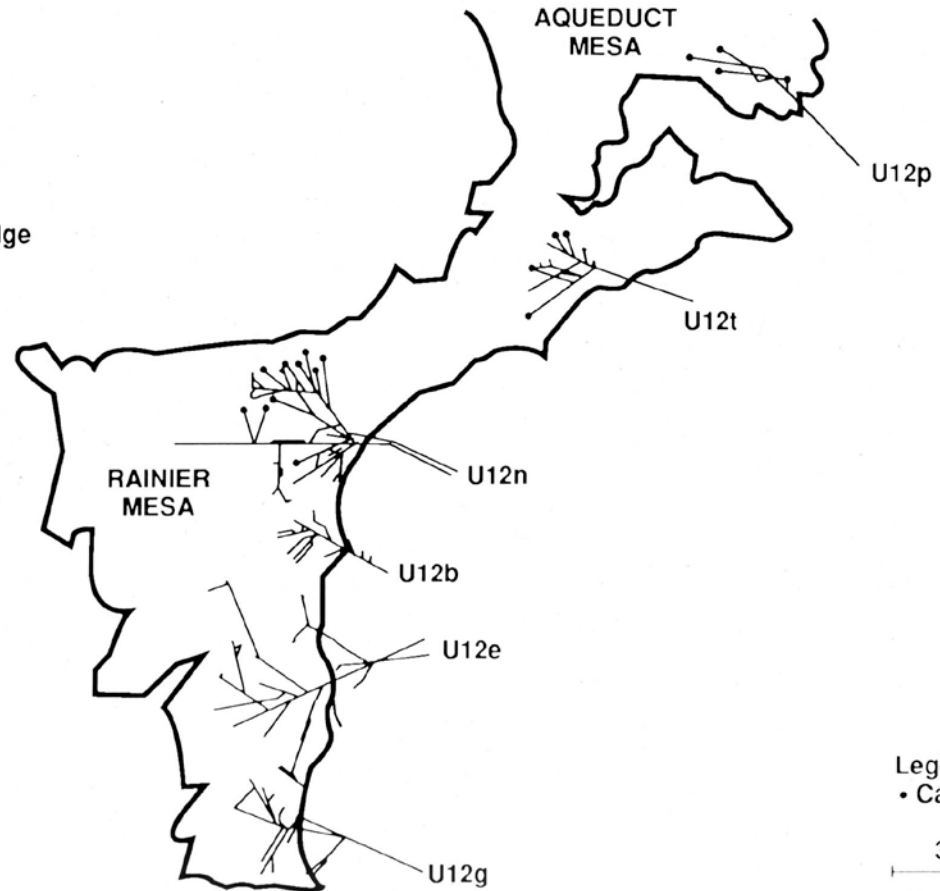


Tunnels at Area 12

- Rainier Mesa



Topographic Edge
of Mesa



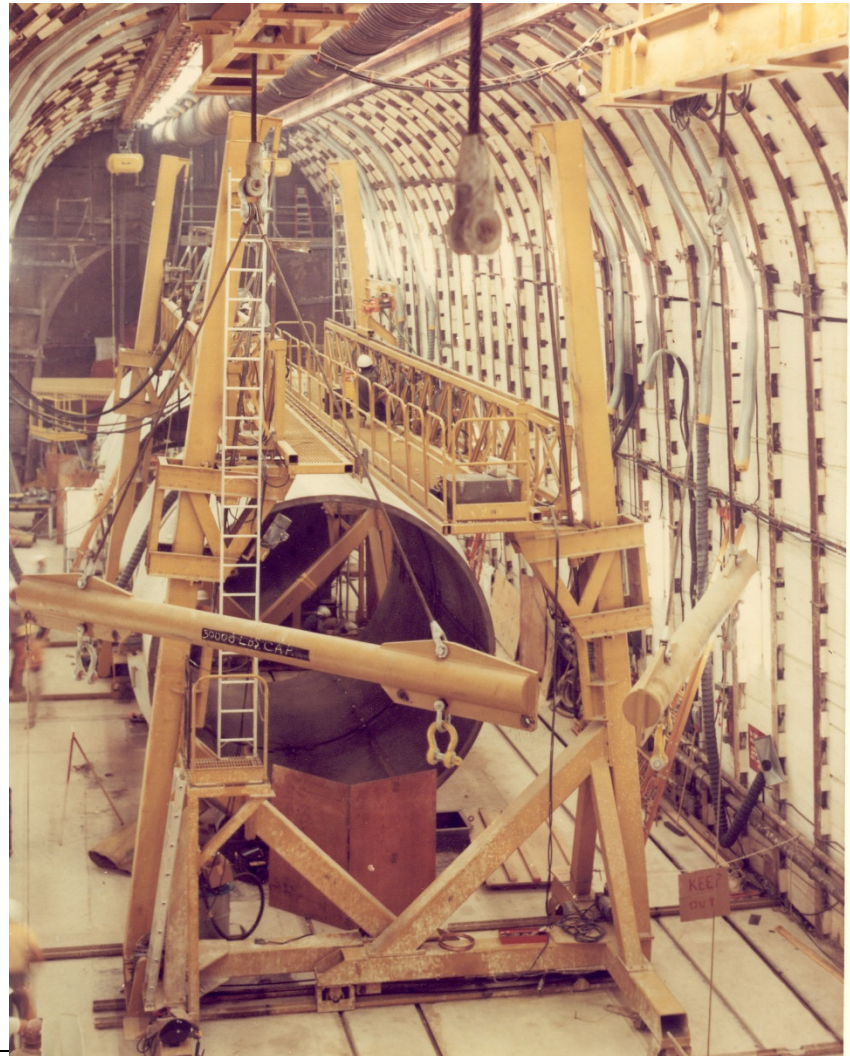
Marshmallow U16a June 1962

- The first HLOS effect test

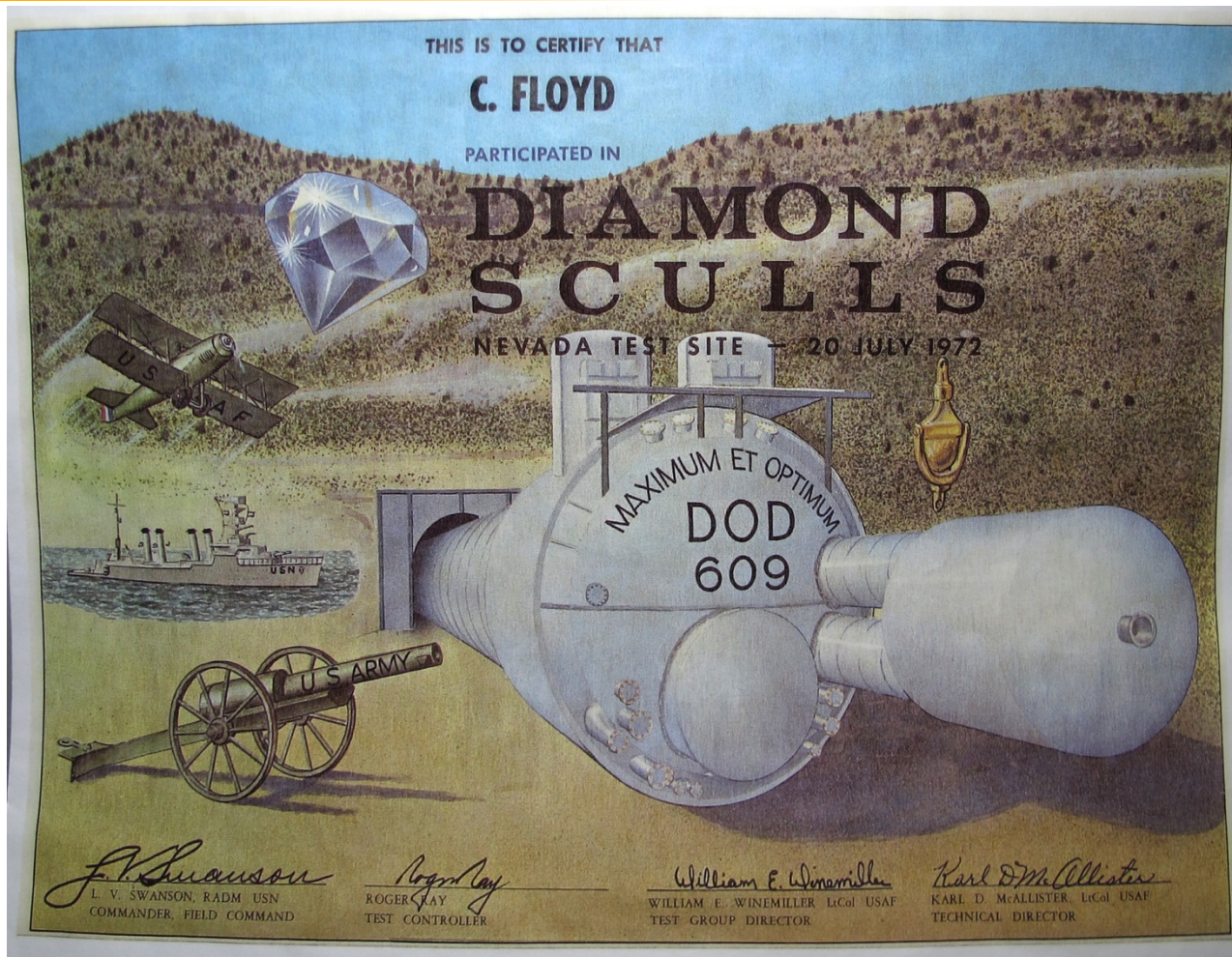


Diamond Sculls - U12t.02 - July 20, 1972

- Radiation Hardness Test of Spartan ABM System
- Largest HLOS Event Conducted
- 27 ft dia. Test Chamber
- 1900 ft long LOS Pipe



Diamond Sculls - U12t.02 - July 20, 1972

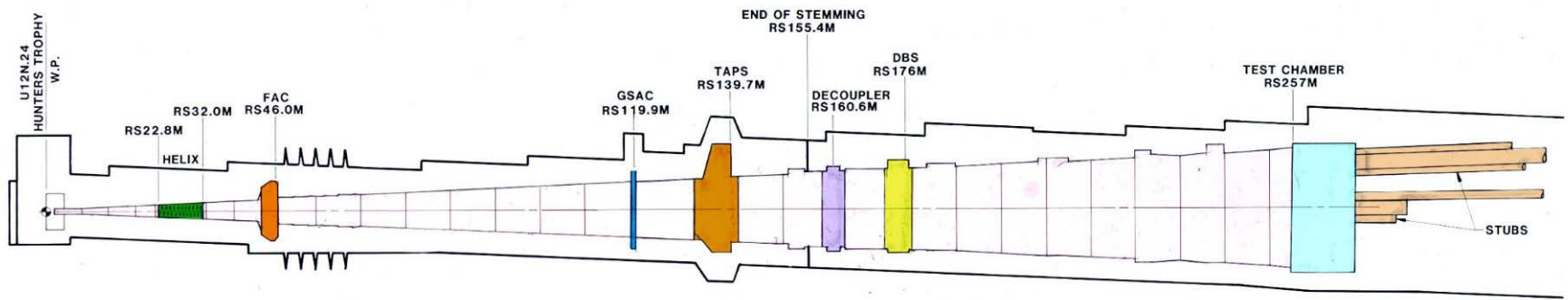


Front End of HLOS

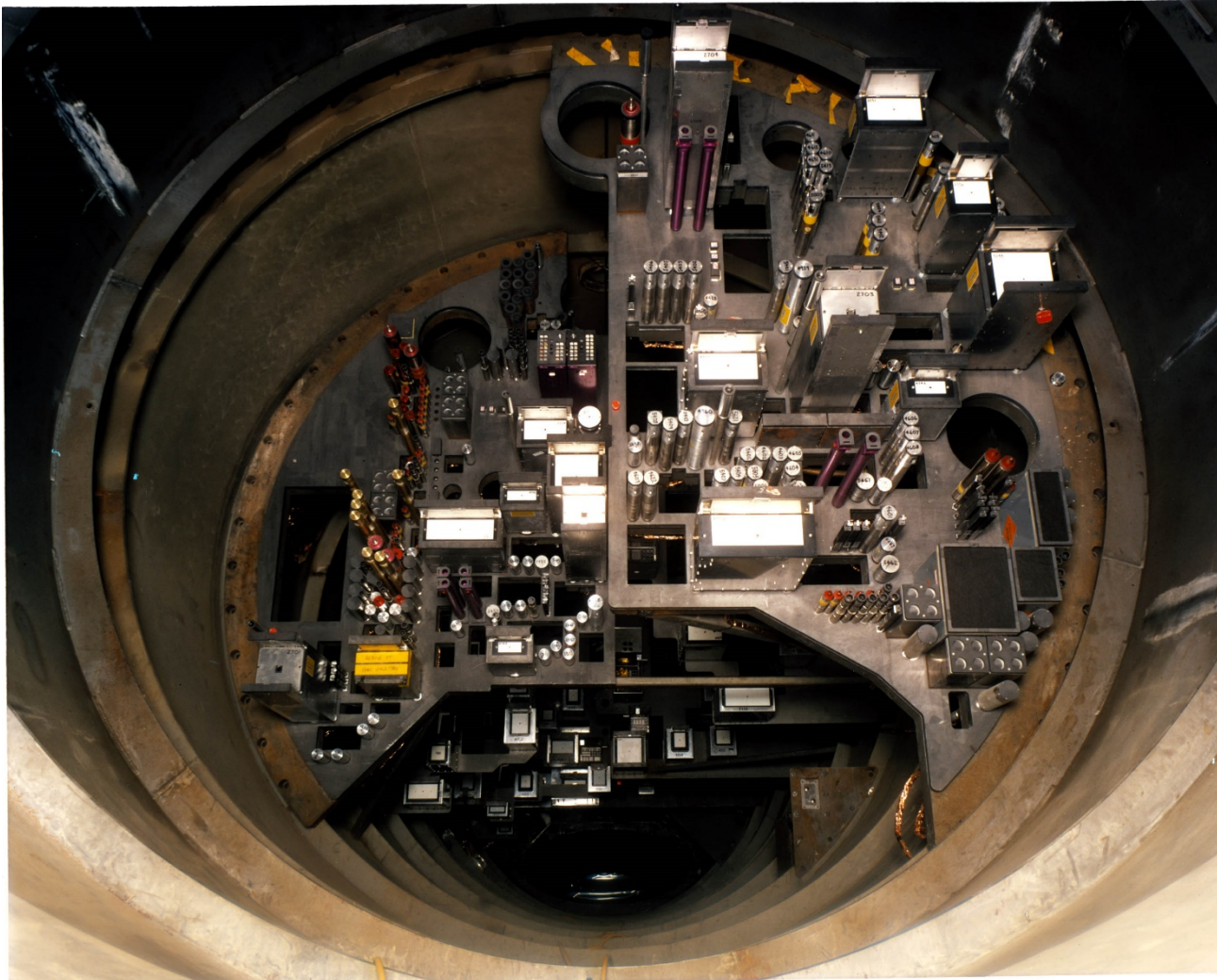


Hunters Trophy Sept 1992

- Purpose: Evaluate radiation hardness of space and high altitude systems
- Technique: HLOS pipe w/test chamber, air scatter, stub pipes to simulate space and high altitude nuclear battlefield environments



Hunters Trophy Test Chamber



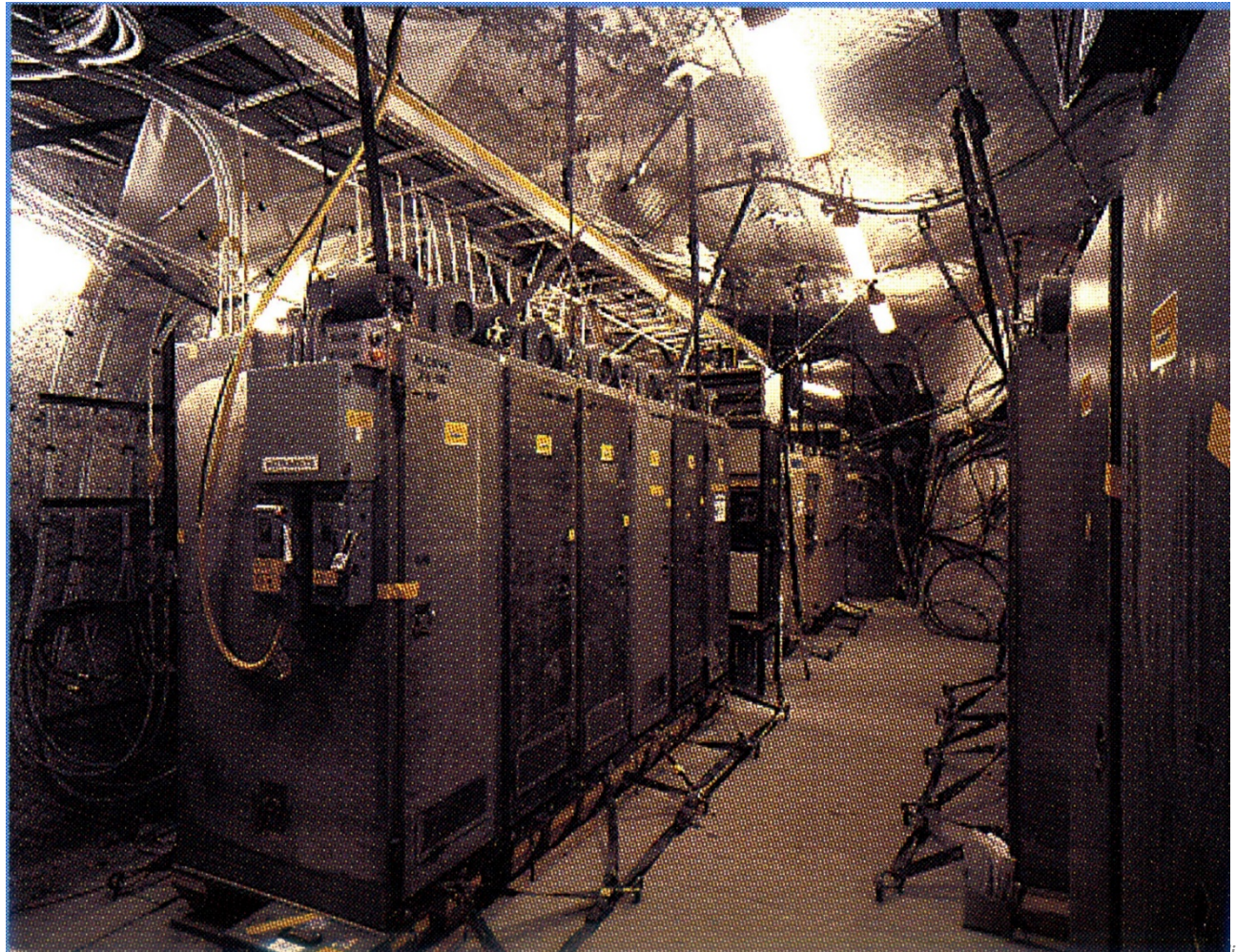
Hunters Trophy HLOS Sieve



Hunters Trophy Instrumentation Cabling



Hunters Trophy Signal Processing Alcove



HUNTERS TROPHY

PARTICIPANT OF

WUL... IT WENT UNDER ALL TH' OTHER BRIDGES!

IT'S A GREAT DAY TO BE IN THE ARMY!

HEAR YE... HEAR YE! THIS WAS THE LAST (NOM) U.G.T. IN 'N' TUNNEL

MON COME THIS IS HERE SO EARLY!!!

DO YOU BUSTER?

LEMMIE IN... BUT I'M TH' BOSS!

CHAMBERNAID DONNA TELLS DEPUTY DIRECTOR YOM KENNEDY... NO GO!!!

DOING!! DOING!!

HEY... THIS ONE IS A LITTLE WELL DONE!!!

I THINK WE CREATED A BLACK HOLE!

POOF

POOF BEEH

SALVAFIA CASSETTE

HIGH STAKES GARFIELD CARD GAMES

B.B. Q. RAT TONITE

Don A. Linger
Director, Test Directorate

James K. Magruder
Test Controller

Gary Reynolds MAJ, USA
Test Group Director

John F. Turner Capt, USAF
Technical Director

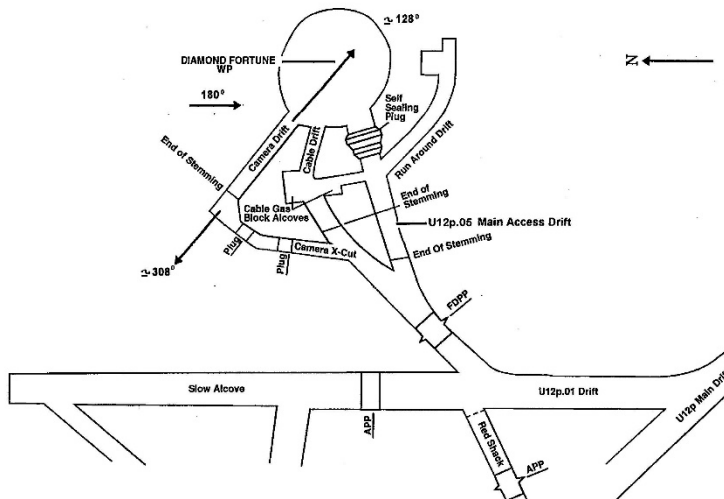
Diamond Fortune Cavity Layout

- DIAMOND FORTUNE was a DoD/LANL-sponsored weapons-effects test conducted at 0930 hours PDT on 30 April 1992. The device was emplaced in a 36-foot radius near-hemispherical cavity at a vertical depth of 776 feet in the U12p.05 drift of the P tunnel complex.



Diamond Fortune Cavity Construction

- The purpose of the DIAMOND FORTUNE test was to investigate the close-in airblast flow fields that would be produced by a modern nuclear device.



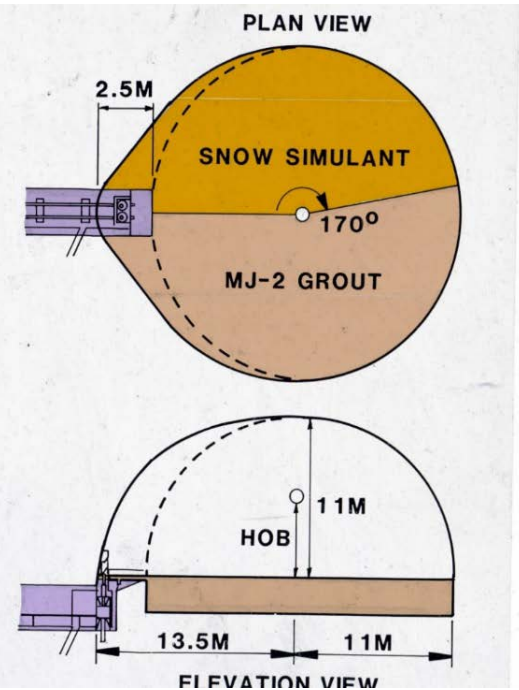
- 11-METER HEMISPHERICAL CAVITY WITH 2.52METER OFFSET

- 4M HOB

- 2 NON-IDEAL SURFACES

- ▲ BARE SOIL

- ▲ SIMULATED SNOW (AGT CHECKOUT ON HURRICANE LAMP)

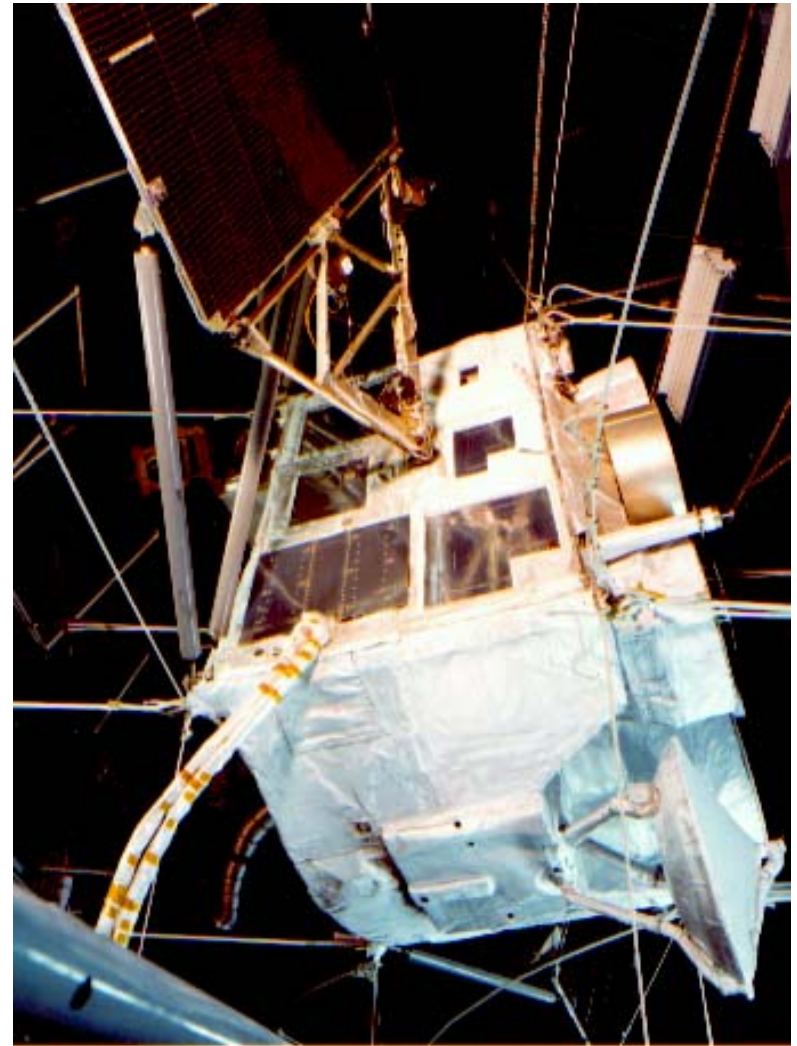


Huron King VLOS Effect Test



Huron King Starsat Experiment

- Tested the radiation hardness of the new DoD DSCS* satellite



*Defense Satellite Communications System

Huron King Subsidence Crater



Current view from
Google Earth



Post Shot



Huron King



CP – Control Point (Now Closed)

- Note all the microwave antennas



CP – Control Point (Now Closed)

- The War Room



Then

vs

Now

- 4 full time “walk in” machine shops
- 40+ full time weather monitors
- 8 full time rack designers
- 40+ safety engineers
 - Oversee all operations for safety
 - (not like todays safety)
- 2 drill teams
- RadSAFE
 - 100+ Staff
- Containment group
 - 10+ Staff to contain underground test
- Geology group
 - 40+ Staff to evaluate drilling and soil conditions for site suitability for testing
- Nuclear detector group
 - 30+ scientist, engineers, techs

- Missing
- Missing
- Missing
- Missing
- Missing
- Missing
- Missing
- Missing

Then

vs

Now

- Swimming pool and movie theatre
- Complete motor pool and gas station
- Hospital
- 200+ travel trailer hook-ups
- Complete Stockroom

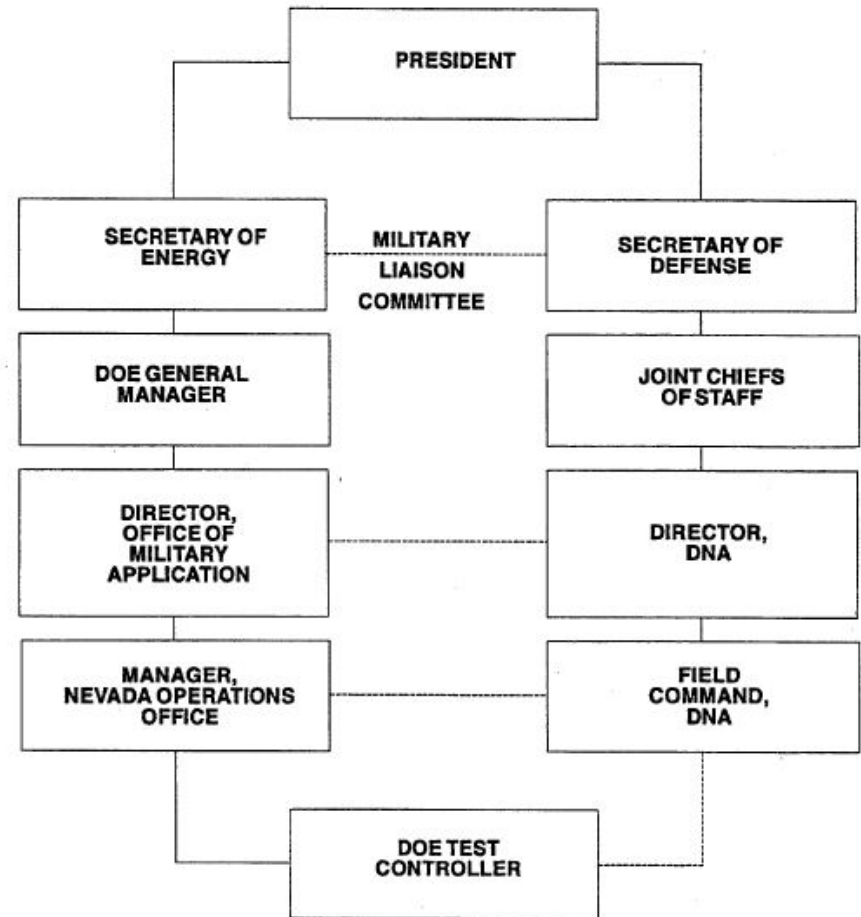
Over 200,000 items from lumber to electronics onsite

- 4 custom electronic fab shops
- Calibration lab
- 200+ Technical trailers
For firing and diagnostics
- Nye County Sheriff
- 3 Cafeterias and a Steakhouse
20,000 meal/day
- Numerous other logistic and scientific function and Agencies

- Missing
- Gas pump but you can't use it
- First Aid
- Missing
- Missing
- Missing
- Missing
- Missing
- 3 that haven't been used in 30 years
- Still there giving speeding tickets
- 2 limited menu lines
one at Wet-n-Wild and one at Mercury
- Missing

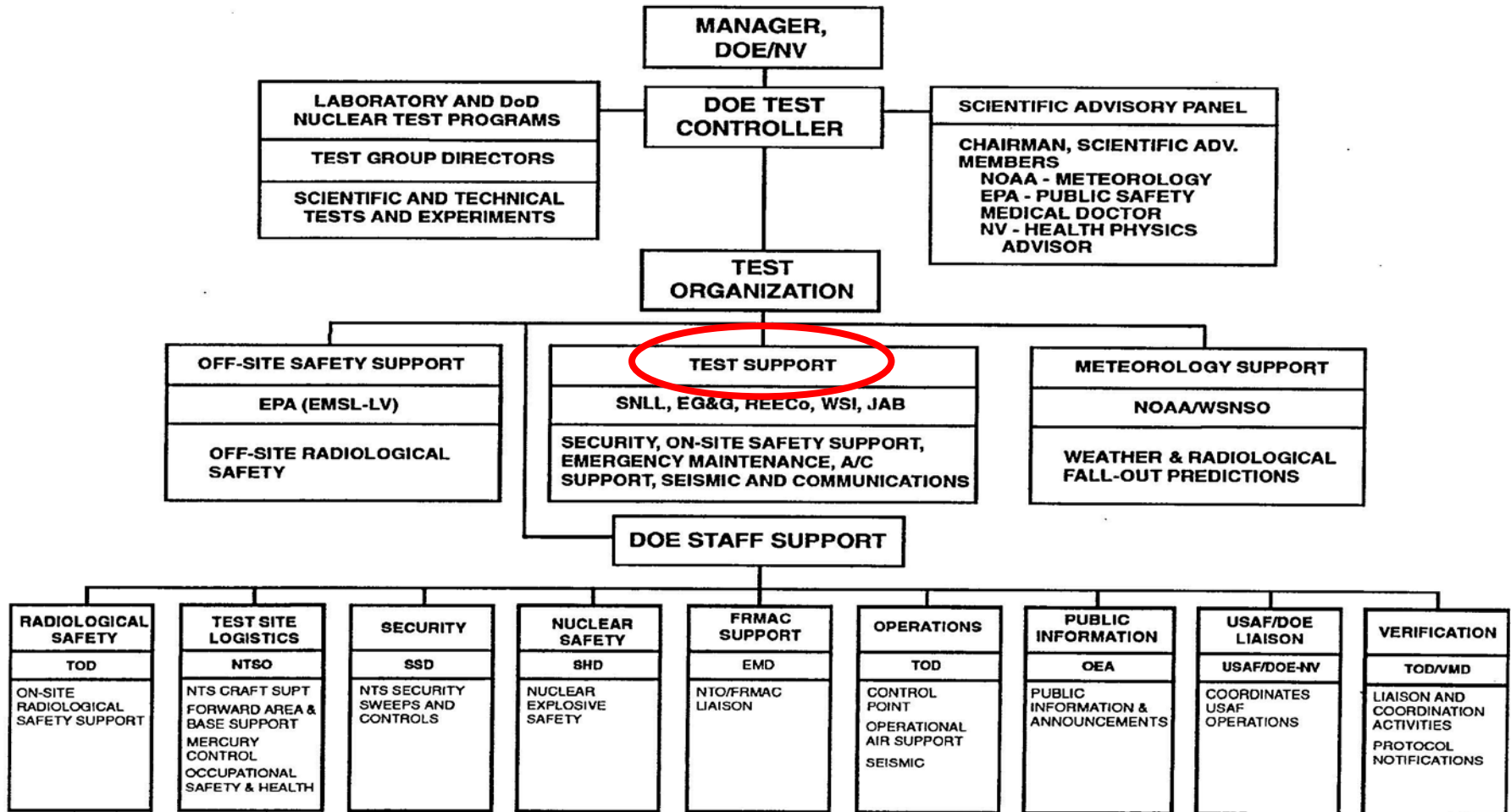
Test Organization (1985-1992)

- Administering the underground nuclear testing program was a joint DOE-DoD responsibility.
- Let's look at DoE first
- We will pick about 1% of the DoE functions to review.



A few examples of what included in these boxes

UNITED STATES DEPARTMENT OF ENERGY NUCLEAR TEST ORGANIZATION



Test Support Organization (1992)

- DoE policy requires the use of private contractors for maintenance, operations, and construction at NTS.
- REECo* was the principal DOE operational and support contractor for the NTS, providing electrical and architectural engineering, state-of-the-art large-diameter and conventional shaft drilling, heavy-duty construction and excavation, mining and tunneling, occupational safety and fire protection, radiological safety, toxic and explosive gas monitoring, communications and electronics, power distribution, occupational medicine, and other support functions. REECo maintained offices in Las Vegas and ***extensive facilities necessary to operate at NTS. REECo had over 4000 full time employees at NTS.***

*REECo Reynolds Electrical and Engineering Co est 1932, now closed.

Test Support Organization (1992)

- EG&G* was the principal technical contractor, providing control point functions such as timing and firing, and diagnostic functions such as scientific photography and measurement of detonation characteristics. In addition, EG&G personnel manned the DoD monitor room. EG&G support facilities were maintained in Las Vegas and at NTS.
- The remnants of EG&G are now part of NSTec.

*Edgerton, Germeshausen and Grier

Test Support Organization (1992)

- There were 7 more full time contractors at NTS providing services from vending machines (which had beer) to Security.

Underground Test Procedures

- Containment Procedures were under the auspices of the Test Evaluation Panel formed in 1961 shortly after the Limited Test Ban Treaty was put in force. Their purview was:

Vertical shaft containment

Tunnel containment

Containment?

Show Video

Containment of US Underground Nuclear Tests

(Post LTBT, Oct 10, 1963)

- 158 vertical tests (shaft/drill hole) had uncontrolled radioactive releases
 - 39 were Los Alamos
 - 119 were Livermore
 - Only 3 were post Baneberry (2 LLNL, 1 DNA)
- 20 horizontal tests (tunnels) had uncontrolled radioactive releases
 - 12 LLNL, 7 DNA, 1 SNL
 - Only 1 was post Baneberry (SNL)

Life After Baneberry

- Containment Evaluation Panel
 - Formed after the 19 March 1971 massive containment failure of the Banberry shot which resulted in a suspension of testing.
- Baneberry released about 7 million Curies.....
that's $3 \times 10^{+17}$ Becquerels for you SI people
- States effected:
 - NV, UT, WY, CA, OR, WA, MT, ID,
WY, ND, SD, MO, AR, TX, MN

New CEP Functions

- Established Effluent Release Procedures
 - Managed Radsafe teams onsite
 - Standby aircraft to track and sample releases
 - EPA offsite monitoring stations
 - Milk diversion program
 - Offsite thyroid monitoring program
- All of these functions are now vacant

Nuclear Test Preparations at LANL Includes

- Shot proposal and approval
Physics experiment, development test, stockpile confidence test, SCT, DoD source
- Test Device Engineering
- Test Device Design and Safety Review (Richter Quote)
- Detonators, GTS, Initiators, etc
- Nuclear Diagnostics
- Electrical and Mechanical Diagnostics
- Assembly
- Device alignment

What LANL Does

- Before we do a nuclear test we do a hydrodynamic test, sometimes several.
- What's involved in a “hydro”

Test Diagnostics

radiography,

timing pins,

pressure gauges,

photography,

interferometer,

magnetic probes,

any special diagnostics such as antennas, etc.

What LANL Don't Do

- Shipping
- Impacement
- Stemming (LANL and Containment Committee Design)
- Firing
- Drill-back for radiochemical analysis
- Several dozen other function such as, venting contingency, EPA approval, etc
- ***MOST IMPORTANT LANL does not authorize a nuclear detonation***

A test can be cancelled at the last minute



Authorization

- The AEC or now the DoE sends a request to the President for his approval



SECRET
UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D.C.

document consists of 2 pages
No. 2 of 12 Copies, Series A

September 8, 1961

SANITIZED COPY

Dear Mr. President:

The purpose of this letter is to obtain your special authorization for expenditure of special nuclear material as has been customary for previous nuclear tests. In accordance with NSC action memorandum number 87, dated September 5, 1961, in which you authorized resumption of nuclear weapons testing, we are now preparing to detonate in a tunnel at the Nevada Test Site on September 15, 1961.

It is anticipated that the will also be ready for detonation on or after that date at the Nevada Test Site. This would be a proof test of the warhead.

As I informed you previously, it is feasible on a "crash" basis to conduct this test on or about September 28. However, complete diagnostic instrumentation cannot be ready by that date and the Livermore Radiation Laboratory advises me that, if it were to be conducted that early, it would be virtually certain that the experiment would have to be repeated at a later date. The with complete instrumentation would be ready to detonate by about October 10. In view of the important technical advantages which this later date affords, our current plan is to on that date. We recognize, however, that there may be overriding policy considerations which would make it necessary to revise our planning and to conduct the test at the earliest feasible time. In that event, we can, at your request, carry out the experiment on the earlier schedule.

SANITIZED
E.O. 12356, Sec. 3,4
NLK-93-93-1
By SF NARA, Date 10/6/93

This document contains restricted data as defined in the Atomic Energy Act of 1954. Its transmission or the disclosure of its contents in any manner to an unauthorized person is prohibited.

- The AEC or now the DoE sends a request to the President for his approval

- 2 -

John Kennedy
Sept 9, 1961

Authorization

- Hopefully the President or a representative responds

SANITIZED COPY

September 12, 1961

MEMORANDUM FOR

**The Secretary of Defense
The Chairman, Atomic Energy Commission**

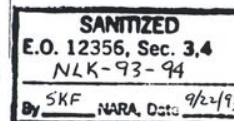
**Subject: Implementation of National Security Action
Memorandum No. 57**

As recommended by the Chairman of the Atomic Energy Commission, the President authorized, on September 9, 1961, the expenditure of specified amounts of special nuclear material for use in the three detonations listed in National Security Action Memorandum No. 57.

The President also approved the recommendation of the Chairman, Atomic Energy Commission, that be detonated about October 10, 1961.

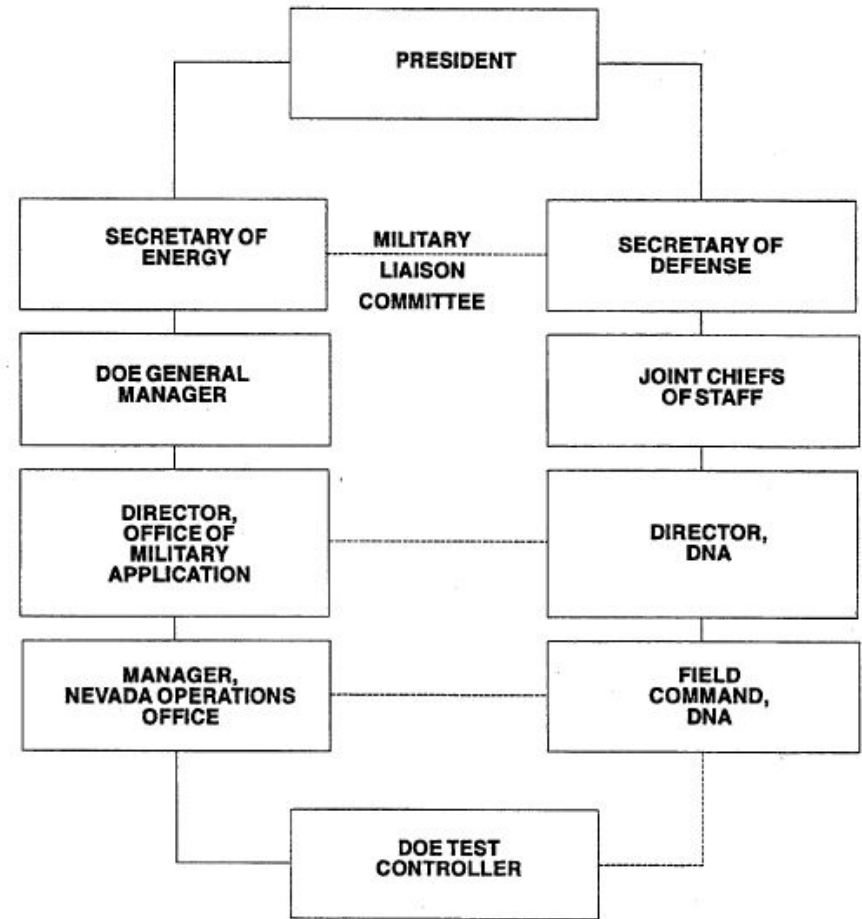
McGeorge Bundy

**Distribution: Orig to Sec Def
cc to Chairman, AEC
info cc to Lucius Battle, State Dept.
info cc to Gen. Taylor
info cc to Chas. Johnson**

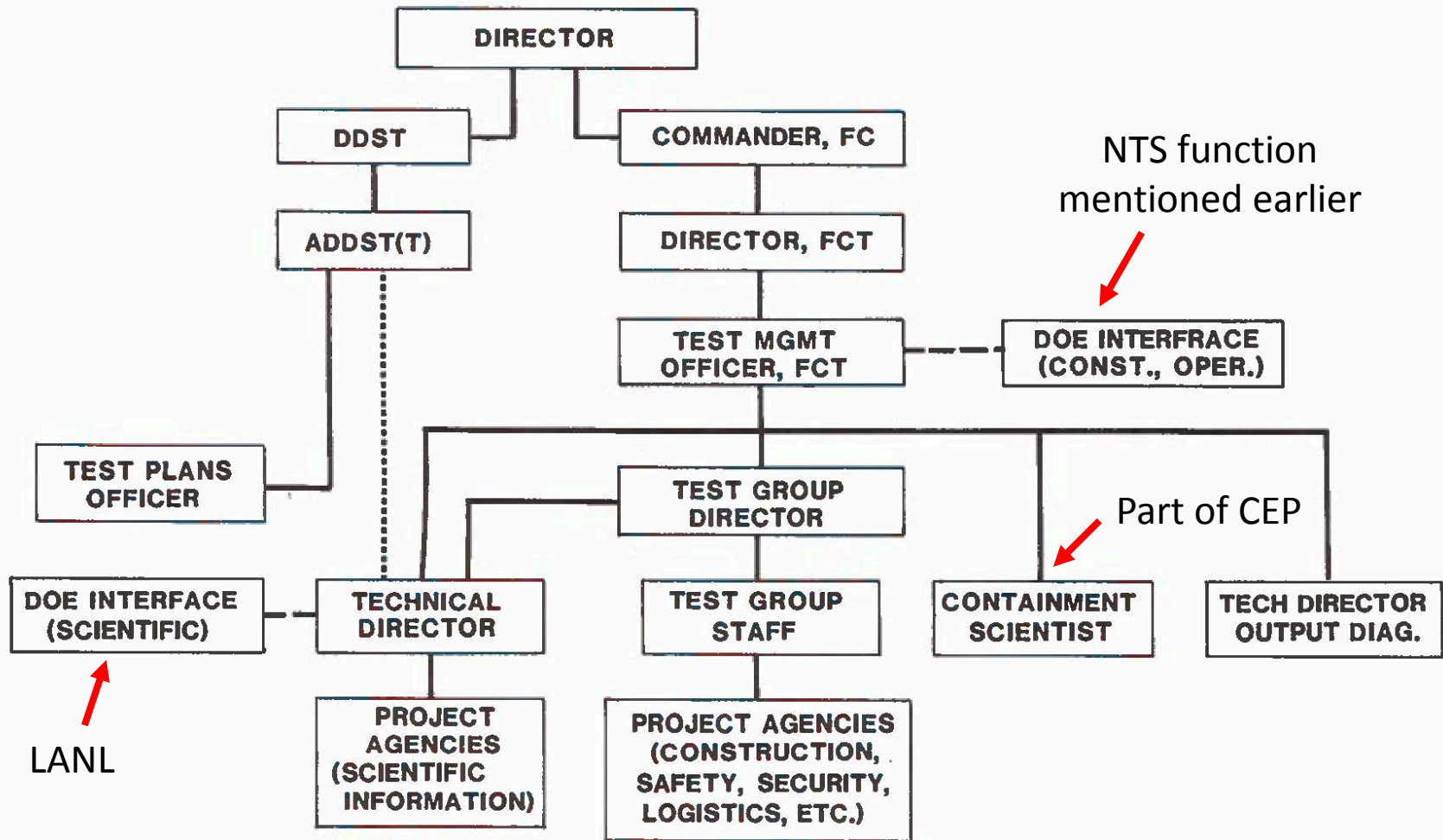


DoD Test Organization (1987)

- Let's take a quick look at the DoD
- Since 1947 this function was performed by successors of the Manhattan Project
- Since 1971 nuclear test conducted for military purposes were directed by the Defense Nuclear Agency, DNA



DNA Test Organization (1988)



DNA Test Organization (1988)

STAFF PERSONNEL LISTING FOR (EVENT NAME)

Test Group Director.....	Grade, Name, Service
*Technical Director.....	Grade, Name, Service
Program Analyst.....	Grade, Name, Service
Instrumentation Engineer.....	Grade, Name, Service
Structure Engineer.....	Grade, Name, Service
Diagnostician.....	Grade, Name, Service
Test Group Engineer.....	Grade, Name, Service
Program Director.....	Grade, Name, Service
Safety Engineer.....	Grade, Name, Service
HQDNA Test Plans Officer.....	Grade, Name, Service

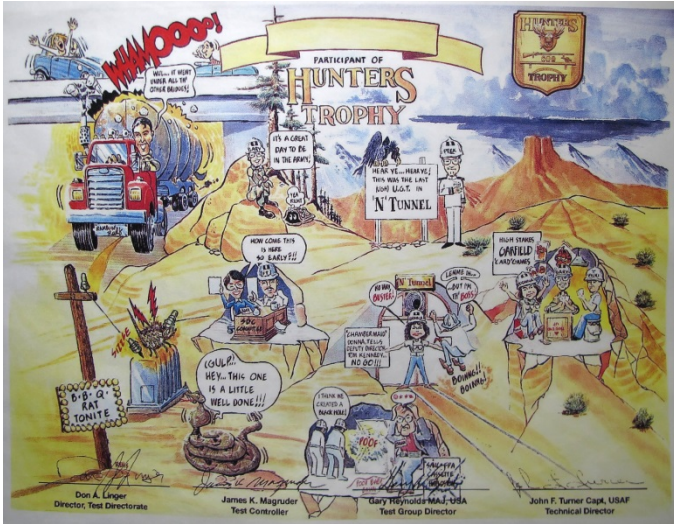
None of the offices exist today

Final Word

- Conducting a nuclear test was a major undertaking
- It involves several hundred full time positions that have little to do with the actual test
- In the 60's Mercury was the second largest city in Nevada
- On a average day in the 60's, 70's AND 80's there were about 20,000 people on the site.
- **One** effects shot would require from 2 to 4 years to plan and execute. These were massive undertakings.
-

The Test Moratorium 1992-

- The U.S. has been in a self imposed test moratorium since 1992
- The last effects test was Hunters Trophy, 18 September 1992, 5 days later,
- The last nuclear test was Operation Julin – Divider, 23 September 1992
- Moratoriums are not new



Divider

The Test Moratorium 1958-1961

- Robert Osborne, (possibly the most notable weapons engineer/scientist ever at LANL) wrote about the test moratorium:

“within 6 months of the moratorium the staff had dispersed to such a point that we had completely lost our ability to perform a comprehensive test”

The Moratorium 1958-1961

- Norris Bradbury on the moratorium:

“Nuclear testing is essential to maintain a viable weapons program because it now takes 4 years from test to stockpile”

